THE SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE

(S E T I)

Our Milky Way Galaxy is only one of 10 billion galaxies in the presently observable universe. Our Sun is just one of some 300 billion stars in our galaxy alone. Astronomers have confirmed that the Sun and the galaxy, which make our existence possible, are not unusual or basically different from other galaxies and stars.

A few generations ago, astronomers believed that planetary systems were extremely rare--that our solar system and our Earth with its life-supporting environment might well be unique. Chemists and biologists knew little if anything about the processes that led to the origin of life. In the last fifteen years, however, a number of important discoveries have strongly suggested that there is a fundamental relationship between the origin and evolution of life and the origin and evolution of the universe.

Advances in astronomy and physics have given renewed support to the concept that planets are not rare exceptions, but are a natural part of the star formation process and may number in the hundreds of millions in our galaxy alone. [In December 1984, the National Science Foundation announced that a team of Arizona astronomers had detected a possible solar system around Beta Pictoris, a star 53 light years from Earth.] Recent biological experiments applying natural energy sources

to molecules have produced some of the organic building blocks that make up the chemistry of life. Radio astronomers have discovered that many organic molecules exist even in the depths of interstellar space. Elements identified in these molecules include hydrogen, nitrogen, oxygen, carbon, silicon, and phosphorus. Earth has been without life only a small fraction of its age, which leads many scientists to look upon the formation of life on other suitable planets as very likely. Once begun, and given billions of years of relative stability, life may achieve intelligence and, in some cases, may evolve into a technological civilization.

One direct way of testing whether intelligent life exists beyond our solar system is to search for an artificially generated radio signal coming from interstellar space. As an example, ultrahigh frequency and microwave radio signals emanating from Earth are expanding into space at the speed of light. This radio, radar, and television "leakage" of ours currently fills a sphere nearly 100 light-years in diameter. The same phenomenon would serve to announce the presence of other intelligent life. Moreover, advanced civilizations might be operating radio beacons, possibly to attract the attention of emerging societies and bring them into contact with a community of long-established intelligent societies existing throughout the galaxy.

Either type of signal (leakage or beacon) would be easiest to detect at frequencies where the background radio noise is minimal. One of the quietest regions of the electromagnetic spectrum is the "microwave window" that lies in the frequency band between 1000 and 10,000

megahertz (MHz). It is reasonable to assume that others wishing to establish interstellar contact by radio might choose this band.

The search for extraterrestrial intelligence (SETI) is not new, having first been proposed by U.S. scientists in 1959. Since that time, numerous scientific and technical studies have been made on an international scale, and more than 30 radio searches have been attempted, covering only a minute area of search space. What is new today is the available technology. Radio telescopes on Earth are sufficiently sensitive to detect signals no stronger than some leaving Earth at distances of a thousand light-years or more. The 305 meter (1000-ft) diameter radio telescope at Arecibo, Puerto Rico, could detect transmissions from nearby stars that are less powerful but similar to our own television and radars. Advances in computers and data processing techniques now make it possible to search automatically through millions of incoming radio signals each second and, if it is present, to identify a signal transmitted by an intelligent society.

The NASA SETI Program is nearing the end of a 5-year research and development phase, using existing radio telescopes and advanced electronic techniques to develop prototype SETI instrumentation. The program is being jointly carried out by the Jet Propulsion Laboratory (JPL) at Pasadena, California, and the NASA Ames Research Center at Moffet Field, California. Leading radio scientists from the national laboratories and academic community have also joined together in the SETI Science Working Group to assist the JPL-Ames team in developing

the instrumentation and the search strategy.

The proposed plan involves two complementary search modes that are designed to cover a range of possibilities. One mode is an all-sky survey that will search the entire celestial sphere over a wide frequency range (1200 to 10,000 MHz plus spot bands up to 25,000 MHz) to cover the possibility that there may be a few civilizations transmitting strong signals, possibly as interstellar beacons. Longer observing times may be allocated to directions that include a large number of stars, especially the galactic plane. The radio telescopes employed will be the 34-meter (112-ft) diameter antennas that are part of NASA's Deep Space Network. The survey will be conducted by moving the telescope across the sky at a constant rate. It will cover at least 10,000 times more frequency space than all previous survey attempts, will be about 300 times more sensitive, and will take about 5 years to complete.

The second mode is a high-sensitivity targeted search that will look for weak signals originating near solar-type stars within 80 light-years distance from Earth. The objective is to examine the possibility that nearby civilizations may have radio transmitters no more powerful than our own. Some stellar clusters and nearby galaxies will also be observed. The frequency range covered will be 1200 to 3000 MHz plus spot bands between 3000 and 10,000 MHz. To achieve very high sensitivity, the targeted search will use some of the largest radio telescopes available, including the 305-meter (1000-ft) diameter antenna at Arecibo, Puerto Rico, and the Deep Space Network's 64-meter

(210-ft) diameter antennas. The number of targets covered will be much larger than previous searches and the range of frequencies covered will be thousands of times greater. The targeted search is expected to take about 3 years to complete.

Current astrophysical knowledge and the available technology make the SETI observing program both timely and feasible. Timeliness also relates to the rapidly-increasing sources of radio frequency interference (RFI) in the microwave band. Portions of the microwave spectrum that directly concern SETI ar subject to allocation to numerous users worldwide, emphasizing the need to proceed with SETI while it remains economically possible with our current technology. If the use of the microwave spectrum continues to increase at its present rate, the greatest exploration opportunity in the history of mankind may be placed economically and technologically beyond our reach for the foreseeable future.

S E T I SEARCH SUMMARY

SEARCH PARTICULARS	SKY SURVEY	TARGET SEARCH

Area Coverage	All directions	1000 stars, regions
Signal search	Continuous Wave	Pulses, drifting CW
Frequency coverage	1200-10,000 MHz + spot bands	1200-3000 MHz + spot bands
Frequency resolution	1000, 32 Hz	1000, 32, 1 Hz
Receiver bandwidth	Wide (~250 MHz)	Narrow (~10 MHz)
Observing time per direction at each frequency setting	0.3 - 3 sec	100-1000 sec
Channels analyzed per second	~10 million	~10 million
Antenna diameter	34 meters	305 and 64 meters
Search duration	~5 years	~3 years

SETI, THE SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE, NASA/JPL

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